

Physical Activity and Baltic Sea Diet are interactively related to Higher Life Satisfaction in Community-living Older Finnish Women, OSTPRE-FPS study

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Abstract

A healthful diet and sufficient physical activity (PA) are related to several health outcomes. However, there is a paucity of data on the association between PA and dietary pattern with life satisfaction (LS) in the older adults aged ≥ 65 . This study investigated the independent and combined association of PA and Baltic Sea diet (BSD) score with LS in older Finnish women. Subjects were 554 women aged 65-72 years from the OSTPRE-Fracture Prevention Study. Women reported the hours and type of PA and lifestyle factors via questionnaires, and dietary intake using three-day food record. Adequate PA was considered according to World Health Organization (WHO) recommendation: PA=0, $0 < \text{PA} < 2.5$ and ≥ 2.5 hours/week. BSD score was categorized based on < 13 or ≥ 13 as median score. LS was self-reported using LS scale with four-items on current 'interest', 'happiness in life', 'ease of living' and 'feelings of loneliness' (range: 4-20, lower score representing higher satisfaction). After adjusting for the confounders, PA was statistically significantly associated with lower LS score (coefficient $\beta = -0.207$, $P = 0.001$), where women with $\text{PA} \geq 2.5$ h/week had the lowest LS score followed by women with $0 < \text{PA} < 2.5$ and $\text{PA} = 0$ (P for trend = 0.020). Association between BSD and LS was not significant. Only among women with BSD score ≥ 13 , but not BSD < 13 , $\text{PA} \geq 2.5$ h/week was statistically significantly associated with lower LS score (mean = 9.3), followed by $0 < \text{PA} < 2.5$ (mean = 9.9) and $\text{PA} = 0$ groups (mean = 11.8) (P for trend = 0.033). In conclusion, adequate PA according to WHO recommendation independently and in combination with higher BSD score maybe associated with higher LS in older women.

Keywords: Physical activity; diet quality, Subjective well-being; Older adults

INTRODUCTION

Most of the developed countries have unified the definition of ‘elderly’ or ‘older person’ for chronological age of 65 years and above ⁽¹⁾. This group of older people are experiencing nowadays greater longevity and have an increasing presence among the community in Europe ^(2,3). Their subjective well-being has faced a significant increase in importance along with the concept of healthy ageing. It has been suggested that a high level of subjective well-being is associated with a decreased mortality and increased life expectancy ^(4,5). In this context, life satisfaction (LS) was further introduced as an indicator of subjective well-being and quality of life ⁽⁶⁾. Different assessment tools have been used to reflect the LS in older adults. In previous studies, where LS status was derived by a four item self-reported LS scale, it has been shown that life dissatisfaction has been associated with different adverse health predictors, such as poor health behavior, self-reported morbidity ⁽⁷⁾, and low social support ⁽⁸⁾ as well as to be an independent predictor of psychiatric morbidity among general population ^(9,10). Life dissatisfaction also predicted major depressive disorders and poor mental health ^(8,10), morbidity, mortality, psychiatric and somatic disability ⁽¹⁰⁾. In an interview, women who answered one-item question on life satisfaction of being unsatisfied had increased risk of cancer, stroke, and type 2 diabetes compared to women who were very satisfied with life ⁽¹¹⁾.

There is much discussion on what factors determine LS ^(12,13), there has been relatively little scientific evidence for the association of modifiable factors such as physical activity (PA) and diet with LS in older adults. Some evidence suggests that chronic illnesses are related to low LS, affective well-being and quality of life in old age ⁽¹⁴⁾. Thus, PA interventions could represent an effective behavioral strategy for mental health, and for enhancing quality of life in older adults ^(15,16). However, to our knowledge studies that have assessed the relation of PA with LS in older adults are scarce. According to World Health Organization (WHO) recommendation, older

adults (65 years and above) should have PA at least 2.5 h per week in order to prevent physical function decline⁽¹⁷⁾.

In addition, consuming varied diet has importance to older adults to obtain all the nutrients needed for good physical and mental health and reduced mortality^(18,19). In older adults higher diet quality has been linked with various health outcomes, including reduced risk of chronic disease, age-related diseases, which potentially results in longevity^(20,21). In prospective studies, a potential protective role of diet quality against depressive symptoms has been suggested^(25,26). In a cross-sectional study, men with a high adherence compared to low adherence to BSD were 40% more likely to be non-depressed⁽²⁷⁾.

The Baltic Sea dietary pattern was introduced in 2013 to characterize healthy Nordic diet (Kanerva et al. 2013). A dietary score represents a summary value of consumed foods or nutrients and characterizes a measure of a predefined (healthy) diet (22). Higher scores indicate better dietary quality and a higher intake of beneficial foods such as whole grains, vegetables, fruits, and fish (22). BSD pattern includes healthy foods typically consumed in the Nordic countries such as apples and berries, roots and cabbage, rye, oats and barley, low-fat dairy products, rapeseed oil, and fish (e.g. salmon and Baltic herring), but it is low in processed meat, red meat and alcohol (23). BSD was inversely associated with abdominal obesity among Finnish men in the National FINRISK 2007 study (23). In Finnish women aged 65-72 years, BSD was associated with better overall physical performance (24). However, there is paucity of data regarding association of BSD with LS and previous studies have focused on the association of dietary patterns and depression. The findings of Lengyel et al. suggested that the daily consumption of vegetables and fruits were associated with better self-rated health and greater LS in a cross-sectional study design⁽²⁸⁾. Thus, it would be tempting to hypothesize that also a healthy diet such as BSD may be associated with higher LS (and better subjective well-being). The objective of the present study was to evaluate both the independent as well as combined association PA and BSD with LS in older women.

METHODS

Study population

Data of the present study were collected from the Osteoporosis Risk Factor and Prevention - Fracture Prevention Study (OSTPRE-FPS) (n= 750), which was a 3-year intervention to investigate the effect of calcium and vitamin D supplementation on incidence of falls and fractures among older women. The subjects were selected from the Finnish population-based OSTPRE-cohort (n= 13,100) ⁽²⁹⁾. The inclusion criteria for this study were similar to OSTPRE-FPS which were age at a minimum of 65 years at the end of November 2002, living in the Kuopio Province at the onset of the trial, not belonging to the former OSTPRE bone densitometry sample, and living in community. The willingness to participate in a calcium and vitamin D trial was enquired via a postal enquiry between August and December 2002. The 3,432 volunteers out of 5,407 (63.5%) were randomized into two groups of equal size without stratification or random allocation sequence by an independent statistician. The subjects were assigned to their groups by postal notification according to the randomization. OSTPRE-FPS was conducted as an open-label trial. In total 3432 women volunteered to participate in the study, and 750 women were randomly invited into this subsample for participating in detailed examinations including measurement of body composition, clinical and physical examinations and laboratory tests. The measurements took place between February 2003 and May 2004.

Data for PA from the self-reported questionnaire was available for 608 women, of which LS data was available for 562 (missing data due to selecting more than one answer). Data for BSD score components was available for 510 women (missing data due to not returning or answering the separate alcohol consumption questionnaire , which results in missing value for some BSD food components).

All clinical measurements were performed in Kuopio Musculoskeletal Research Unit of the Clinical Research Center, University of Kuopio. All participants provided written consent. The study was approved in October 2001 by the ethical committee of Kuopio University Hospital. The study was registered in Clinical trials.gov by the identification NCT00592917.

Dietary intakes

Dietary intake was assessed by using a 3-day food record based on the amount of food consumed. The questionnaire and the instructions were sent to participants beforehand, and they were returned on the visiting day. Questionnaire included 3 consecutive days, with 2 days during the week and one day in the weekend (Saturday or Sunday). In case of uncertainties in the food record, a nutritionist called the participant for additional information⁽³⁰⁾. Assessment of underreporting has previously been reported and none of the participants was excluded due to low energy intake⁽³⁰⁾. Consumption of foods and the intake of nutrients were calculated using Nutrica program (version 2.5, Finnish Social Insurance Institute, Turku, Finland).

Baltic Sea diet score

The detailed calculation for BSD score has been explained previously in this data⁽³¹⁾. The BSD score consisted of nine components, of which five were foods or food groups and four nutrient intakes. The BSD score included positive components: 1) fruits and berries, 2) vegetables (root vegetables, legumes, nuts, mushrooms and vegetable products—potatoes excluded), 3) fiber from cereal products, 4) low-fat milk (skim milk and milk with fat content less than 2 %), and 5) total fish intake; and a negative component 6) processed meat products (sausage), 7) Total fat intake was expressed as a percentage of total energy intake (E %), 8) Quality of fat intake was represented by calculating a ratio of polyunsaturated fatty acids (PUFA) to saturated fatty acid (SFA). 9) Frequency of consumption of alcohol portions (1 portion=12 g) was asked in a separate questionnaire. Construction of BSD score is summarized in **Supplementary Table 1**. To calculate

BSD score, subjects were categorized into quartiles according to the BSD score components. For the positive components 0 score was given to the lowest quartile, and 3 score was given to the highest quartile [Q1=0, Q2=1, Q3=2, Q4=3], scorings for negative components were reversed. For alcohol consumption, score was assigned as 1, if alcohol intake was ≤ 12 g/d and otherwise= 0. BSD score ranged from 0–25, higher points indicating higher adherence to BSD. Further the BSD median intake (BSD<13 vs. BSD \geq 13) was used as to create dichotomic variable and a balance number of women in each group.

Physical activity

PA data were collected via a self-administered questionnaire where participants were asked to report the type, hours, and seasonality (winter and summer) of their PA. Types of PA included walking, cycling, skiing, swimming, aerobic exercise, sport balls, skating, floor ball, gymnastics and rowing. Weekly amount of PA in winter and summer were calculated and the average of them was used as an estimate of long-term PA. Further for categorical analyses, we used the cut-offs adapted according to WHO recommendations for the amount of PA per week in older adults ⁽¹⁷⁾. Women were categorized into PA=0 h/week, 0<PA<2.5 h/week and PA \geq 2.5 h/week. We have also introduced a continuous variable of PA as per 1-unit increase.

Life satisfaction

The main outcome of this study is LS which is previously strongly linked with depressive symptoms ⁽⁸⁾. It has also identified those with increased risk for several adverse health outcomes such as mortality⁽⁹⁾, suicide ⁽³²⁾, and both psychiatric and somatic disability ^(33,34). In brief, the scale assesses current interest and happiness in life, ease of living and feelings of loneliness ranging from 1 ('very') to 5 ('not at all') except for loneliness which ranges from 1 to 4 and it was reversed before computation of the sum LS score ⁽³⁵⁾.

Confounders

Data regarding lifestyle were self-reported, such as income per month (euros), marital status (married, divorced, widowed, and not married), smoking status (never, past, and current), medical history, medications (incl. hormone therapy), and time since menopause⁽³⁶⁾. We defined multimorbidity as the presence of 2 or more of chronic conditions, including hypertension, hyperlipidemia, coronary heart disease, diabetes, arthritis, osteoporosis, depression, chronic kidney disease, and cancer. Height and weight were measured with participants wearing light indoor clothing without shoes, and BMI was calculated (kg/m^2). Mobility was defined as normal if women were a) fully capable to move; b) capable to move, but unable to run, or c) capable to walk 1 km at the most. It was defined as restricted when women were a) capable to walk 100 m at the most, b) move only indoors or c) incapable to move.

Statistical analysis

Characteristics were compared in LS score quartile categories using Pearson chi-square test for categorical variables, and ANOVA for continuous variables. ANOVA was used for testing the LS in the BSD categories according to median score (BSD median score=13) and three groups of PA. We calculated the standardized coefficient β by testing the regression of PA and BSD with LS score. An interaction term between BSD and PA was introduced into regression analyses with LS as an outcome, and associations were statistically significant in both unadjusted ($P=0.010$) and adjusted ($P=0.003$) models. PA was categorized into three groups as explained above. In addition, to include a balanced number of participants and ensure the statistical power, we used the median BSD score (=13) in the categorical analyses.

The P for trend was calculated on a linear trend across PA and BSD interaction groups by using the median value in each category as a continuous variable in a multivariable linear regression analysis with LS as continuous dependent variable. Further, univariate analysis of ANOVA was conducted to calculate means (SD) for LS across the BSD and PA interaction groups.

Analyses were adjusted for age (years) and energy intake (kJ/d), BMI (kg/m²), PA (h/week) (only when BSD was set as exposure), years since menopause, smoking status (current smoker), mobility status (normal, and restricted), income per month (euros), multimorbidity and marital status. All statistical analyses were executed using SPSS software version 24 for windows (IBM Corp., Armonk, NY). Differences were considered statistically significant if $P < 0.05$.

RESULTS

Main characteristics of women according to LS score quartile are presented in Table 1. Women belonging to highest quartile of LS score (dissatisfied) had lower PA (h/week), lower alcohol consumption and were less likely to be current smokers. The main PAs reported were skiing, walking, cycling, swimming and aerobic exercise, which explained over 90% of the weekly PA (data not shown), and accordingly they were used to compute the final PA variable in this study.

Main characteristics are presented also according to PA and BSD groups (Supplementary tables 2-3). Women with PA= 0 h/week (n=77) had the highest values for BMI and LS score, whereas consumed less energy, and protein when compared to their peers. Women with PA \geq 2.5 h/week had lower BMI, lowest LS score (satisfied), and highest values for BSD score, energy and protein intake. Those with at least median BSD score (BSD \geq 13) were more physically active, and less often smokers.

We did not observe any statistically significant associations between BSD as continuous variable, or quartile categories with LS score (**Table 2**). In the analysis of continuous PA, we observed an inverse statistically significant association with LS score (coefficient $\beta = -0.207$, SE=0.037, and P for trend= 0.001). In the univariate analysis of ANOVA subjects with PA \geq 2.5 h/week had statistically significant lower LS score (mean=9.4) followed by 0<PA<2.5 (mean=10.3) and PA=0 groups (mean=10.8) (P for trend=0.020) (**Figure 1**).

Interaction of BSD and PA with LS

The interaction of PA and BSD was statistically significantly associated with lower LS score ($P=0.010$ and full adjusted $P=0.003$) (**Table 2**). Among women with BSD score ≥ 13 , those with $PA \geq 2.5$ h/week had statistically significantly lower LS score (mean=9.3), followed by $0 < PA < 2.5$ (mean=9.9) and $PA=0$ groups (mean=11.8) (P for trend= 0.033). Whereas among women with BSD score < 13 association of PA with LS score was not statistically significant (P for trend= 0.069) (**Figure 2**).

DISCUSSION

As the population gets older, health outcomes like LS become progressively more important. The present study is the first to evaluate the independent and combined association of PA and BSD with LS in older women. Women with $PA \geq 2.5$ had the lowest LS score (more satisfied) followed by $0 < PA < 2.5$ and $PA=0$ h/week groups. We did not observe statistically significant associations between BSD as continuous variable and LS. In the stratified analysis, we observed that women with $PA \geq 2.5$ h/week and BSD ≥ 13 (median) had the lowest LS score, while those with $PA=0$ h/week and BSD < 13 had the highest LS score.

WHO recommends at least 150 minutes (2.5 h) per week of PA to older adults (aged 65 years and above) to maintain their physical fitness which could promote both physical and mental health ⁽¹⁷⁾. The precise mechanisms by which PA may promote subjective well-being are yet to be determined. PA may enhance an individual's positive emotions, which are an important element in protecting individuals from illnesses and promoting psychological and physical health ⁽³⁷⁾. PA appears to decrease symptoms of depression, anxiety and tension, and to improve mood. Findings from previous studies have suggested that PA was positively associated with quality of life in older adults ^(13,16), where quality of life was assessed by the satisfaction with life scale. In addition, in a recent study it was shown that leisure-time at least mild PA (duration/frequency) involvement was a significant predictor of LS for older adults with a high level of loneliness ⁽³⁸⁾. LS was measured using Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) answering to the

following question, ('In most ways, my life is close to ideal'). Our findings showed that sufficient PA according to WHO was associated with higher life satisfaction.

Studies on diet quality and LS in older adults are scarce. Mediterranean diet has been associated with lower depression rate in older adults ⁽²⁶⁾. In a young population (17-30 years), LS has been positively associated with higher Mediterranean diet score, non-smoking, physical exercise, eating fruit, and limiting fat intake ⁽³⁹⁾. The differences in the population age and LS assessment scales of previous studies should be noted. In community-dwelling Canadian older men, better self-rated health and greater LS were strongly associated with the daily consumption of vegetables and fruits ⁽²⁸⁾. The LS was assessed with the following question: "How would you describe your satisfaction with life in general at present?" with a 5-point Likert scale ranging from excellent to bad satisfaction. Dietary consumption was estimated with exploratory questions, not with validated measures. In our study, higher BSD score was associated with beneficial health indicators such as less frequent smoking and more PA, but no association with the LS score was observed.

A healthful diet along with sufficient PA according to WHO recommendations can be the optimal way to promote physical and mental health in older people. One explanation for such an association can be that a better diet quality maybe an indirect effect of increased health consciousness associated with adoption of regular exercise habit. Our findings suggested a statistically significant interaction between PA and BSD on the LS score. The most advantageous group i.e. those with $PA \geq 2.5$ h/week and BSD score higher than median (BSD score ≥ 13) were most satisfied with their life. Although further prospective studies are required, this finding can carry a significant public health message that a combination of higher PA and BSD can be linked to overall satisfaction of life.

There are some limitations of this study to be considered. The data was initially collected in 2003-2004. Thus, it maybe that some aspect of the data collection would not confer totally to current available methods used to collect data for studies with similar hypotheses. For practical reasons, PA

questionnaires are currently the most commonly used assessment method of PA in large population-based cohort studies. However, the agreement between different PA questionnaires for correctly revealing individuals as physically active (e.g. meeting the older adult PA recommendations of >2.5 h/ week) is challenging ⁽⁴⁰⁾. In addition, a common limitation to this method is over-reporting of PA. This might result in an overestimation of subjects to be allocated as sufficiently physically active when PA is assessed with self-report. Furthermore, although BSD score computational method has been previously explained ⁽³¹⁾, computing dietary scores such as BSD using 3-day food record has limitations as it may not provide complete data on the habitual food consumption as well as the frequency of food consumption. Noteworthy that energy intake among our study population was relatively low which may be due to underreporting (conscious or unconscious) or by actually reducing their typical level of food intake ⁽⁴¹⁾. However, none of the participants met the threshold to be excluded from analyses based on basal metabolic rate as explained before ⁽⁴²⁾. As the participants were relatively young and rather healthy older women from a homogenous Finnish population, generalizing the results to the entire older adult population should be done with caution. The present study could not capture temporal changes during previous years in respect to long-term diet, quality of life or health status, which all could affect each other. Data analyses were adjusted for several possible confounders, yet the possibility of residual confounding cannot be excluded.

In conclusion, higher PA among older women may be associated with higher LS both independently and combined with a high BSD score. Studies like this may carry an important public health message that a combination of sufficient PA and a healthful diet quality might have beneficial relationship with overall LS among older women. However, further longitudinal studies are warranted to increase the knowledge on the role of PA and diet in LS.

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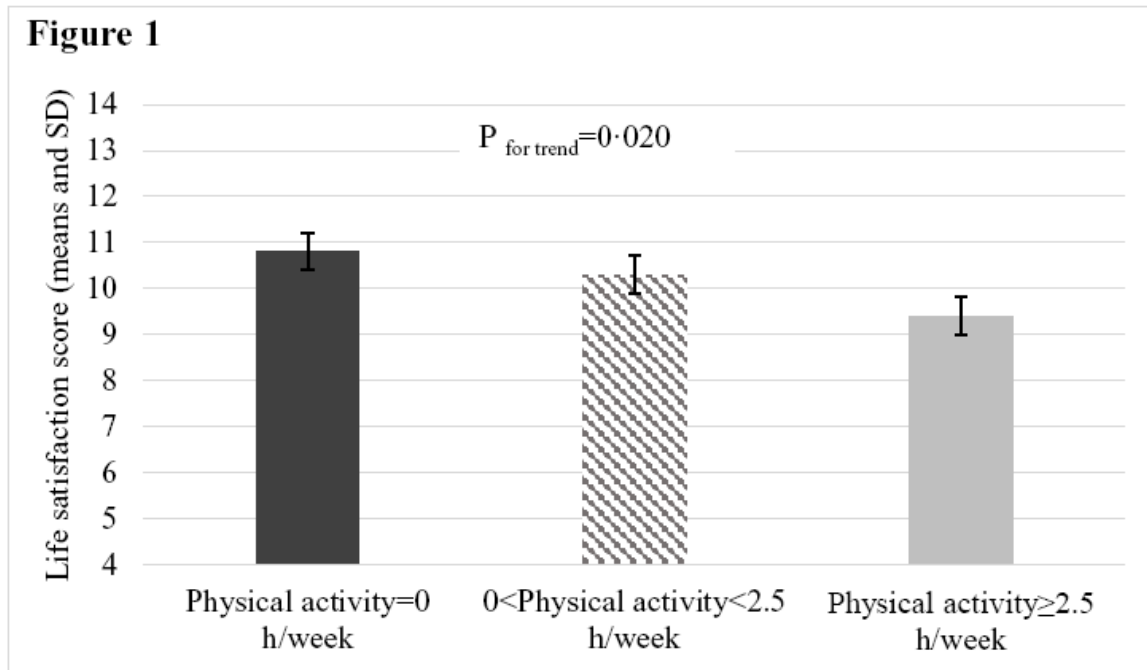


Figure 1. Life satisfaction score (means and standard deviations) according to physical activity (PA) groups. Univariate analysis of ANOVA adjusted for age (years), total energy intake (kJ/d), body mass index (kg/m^2), years since menopause, smoking status (current smoker), mobility status, income per month (euros), multimorbidity and marital status. P for trend was calculated on a linear trend across PA groups by using the median value in each group as a continuous variable in a multivariable linear regression analysis with LS as a continuous dependent variable.

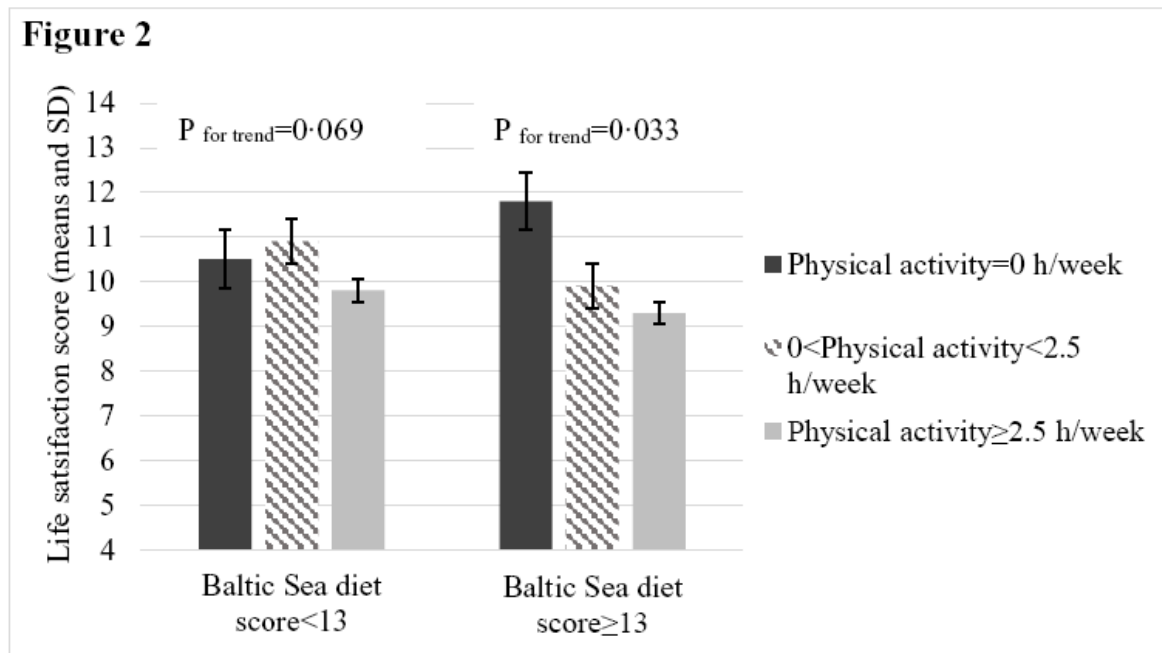


Figure 2. Stratified association of physical activity with life satisfaction score (means and standard deviations) according to Baltic Sea diet score median value. Univariate analysis of ANOVA adjusted for age (years), total energy intake (kJ/d), body mass index (kg/m²), years since menopause, smoking status (current smoker), mobility status, income per month (euros), multimorbidity and marital status. P for trend was calculated on a linear trend across PA groups when analyses were stratified according to median BSD score (<13 vs. ≥13). The number of women in the groups were (n=510): PA=0 h/week (BSD<13, n=9 and BSD≥13, n=22); 0<PA<2.5 h/week (BSD<13, n=84 and BSD≥13, n=60); and PA≥2.5 h/week (BSD<13, n=157 and BSD≥13, n=158).

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Table 1. Characteristics and Dietary Factors of the Participants according to life satisfaction score quartiles (Numbers are means and SDs if not otherwise stated) *.

	Quartile 1 n=149 (6-9)	Quartile 2 n=236 (10-13)	Quartile 3 n=55 (14-16)	Quartile 4 n=122 (>16)	P
Physical activity (h/week)	4.2 (1.4)	4.5 (1.7)	3.8 (1.1)	3.5 (1.3)	0.016
Age (years)	67.5 (1.8)	67.9 (1.8)	67.6 (1.8)	67.9 (1.8)	0.110
BMI (kg/m ²)	27.4 (4.0)	27.3 (4.2)	26.7 (4.2)	28.0 (4.1)	0.311
Income (euros/month)	911 (252)	878 (329)	769 (231)	817 (300)	0.059
Number of chronic disease	1.5 (1.2)	1.4 (1.2)	1.2 (1.0)	1.5 (1.1)	0.379
Restricted mobility <i>n</i> (%)	5 (3.6)	16 (7.2)	3 (6.4)	13 (12.5)	0.066
Current smoker <i>n</i> (%)	6 (4.3)	9 (4.1)	6 (12.5)	4 (3.7)	0.038
Current hormone therapy <i>n</i> (%)	39 (27.7)	51 (22.8)	8 (16.3)	18 (16.7)	0.147
Currently married <i>n</i> (%)	96 (65.3)	164 (69.7)	30 (54.5)	71 (58.7)	0.217
Dietary factors					
Energy intake (Kcal/d)	1564 (376)	1588 (350)	1511 (343)	1543 (417)	0.515
BSD score	12.7 (4.1)	13.1 (4.2)	13.3 (3.2)	12.9 (3.7)	0.739
Alcohol (g/d) †	11.9 (16.6)	11.5 (19.7)	7.7 (10.7)	6.1 (12.1)	0.022
Protein (g/d) ‡	68.7 (18.1)	68.6 (16.7)	66.7 (15.7)	66.7 (20.9)	0.738
Carbohydrate (g/d) ‡	193.5 (49.1)	196.3 (47.4)	185.6 (42.6)	190.9 (53.3)	0.711
Fat (g/d) ‡	53.2 (16.6)	54.9 (17.9)	52.0 (17.1)	53.7 (20.3)	0.505

*Characteristics were compared according to LS quartile as the outcome using Pearson chi-square test for categorical variables, ANOVA for continuous variables.

† Alcohol consumption as g/d was computed using the original variable which was based on the portions per day where 1 portion was calculated as 12 g alcohol.

‡ All macronutrients are energy adjusted.

Table 2. Association of Baltic Sea diet score, and physical activity with continuous life satisfaction score.

	Coefficient β (SE)	95% confidence interval	P for trend	P for trend, adjusted *
BSD score \dagger	-0.016 (0.03)	-0.077- 0.055	0.729	0.673
BSD score quartiles, LS means (SD) \ddagger			0.311	0.251
Quartile 1, n=146	9.7 (3.1)			
Quartile 2, n=125	10.4 (2.8)			
Quartile 3, n=129	9.8 (2.9)			
Quartile 4, n=107	9.4 (2.4)			
PA (h/week)	-0.207 (0.37)	-2.051- -0.568	0.004	0.001
PA categories (h/week), LS means (SD)			0.035	0.015
PA=0, n=77	10.7 (0.53)			
0<PA<2.5, n=166	10.3 (0.31)			
PA \geq 2.5, n=365	9.2 (0.20)			
BSD and PA Interaction	-0.181 (0.021)	-0.129- -0.026	0.010	0.003

*Analyses were adjusted for age (years) and energy intake (kJ/d), BMI (kg/m²), PA (hours/week) (only when BSD was set as exposure), years since menopause, smoking status (current smoker), mobility status (normal, and restricted), income per month (euros), multimorbidity and marital status.

\dagger Regression analysis was used to compute coefficient β , standard error (SE), 95% confidence interval

\ddagger Univariate analysis of ANOVA was used to compute means and standard deviations.